The University of British Columbia Sustainable Seafood Project – Phase II:

An Assessment of the Sustainability of

Bivalve

Purchasing at UBC

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INTRODUCTION

State of Global Fisheries

The biological production of the oceans has increasingly contributed to the global food supply production and to employment opportunities throughout the world (Organisation for Economic Co-operation and Development (OECD), 2005; the Food and Agriculture Organization of the United Nations (FAO), 2004). In 2003, humans directly consumed 76% of the production from fisheries and aquaculture and these operations provided a source of employment for 38 million individuals (FAO, 2004). With fisheries stocks around the world being depleted (Pauly *et al*., 2002) and the remaining 25% of the world's fish populations moderately exploited (OECD, 2005), the increased consumption of fisheries products cannot be realistically sustained. Awareness and discussion about the issues related to the rising scarcity of fisheries resources have been increasing for some time (Swenerton, 1993; Tyedmers, *et al*., 2005). Some well-known examples of commercially important fishery collapses include the closures of the Atlantic cod fishery of eastern Canada (Walters, 1986), and the Peruvian anchoveta fishery of western South

America (Glantz and Thompson, 1981). Today, researchers are finding evidence to support the hypotheses of the oceans decreasing biodiversity, decreasing mean tropic levels, the detriment of by-catch and the irreversible destruction and alteration of marine ecosystems, attributed to the present fisheries management over exploiting stocks (Pauly *et al*., 1998; Myers and Worm, 2002; Worm *et al*, 2006).

Major concerns plaguing fish populations today include over-fishing, by-catch, and habitat destruction stemming from unsustainable management regulations (FAO, 2004). The rise of aquaculture also presents new problems that affect wild fish populations (FAO, 2004). World wide, organizations are attempting to address complex fishery issues with global conservation and management strategies. Initiatives such as sustainable aquaculture, the FAO's Code of Conduct for Responsible Fisheries (FAO, 1995), creation of marine protected areas, the Convention on Biological Diversity's (CBD) recommendations for preserving marine and coastal environments (SCBD, 2006) and sustainable seafood education programs (Blue Oceans Institute (BOI), 2006; Sustainable Seafood Canada, 2006; Monterey Bay Aquarium (MBA), 2006a; Sierra Club of Canada-BC Chapter, 2006; Tank, 2006) have been developed.

Sustainable Seafood

Seafood products that come from sources of wild capture or culture systems that are not damaging to the population, and can be maintained in the long term without harming the surrounding ecosystem, are considered sustainable (David Suzuki Foundation, 2006; MBA, 2006b; Sustainable Seafood Canada, 2006b). Increasing public awareness about how consumption habits affect the health of fish populations provides a direct link between the public and their personal contribution to the status of marine ecosystems (Jacquet and Pauly, 2006). A pioneering example of this was the drive to eliminate dolphin by-catch in the tuna fishery. In 1988, environmental and animal rights groups such as Greenpeace (www.greenpeace.org) approached the problem at the consumer level by advocating a boycott of the major tuna producers in the United States (Constance *et al*., 1995). The boycott raised awareness of dolphin by-catch in the tuna fisheries; as a result, the tuna processors announced they would accept only dolphin-safe tuna (Constance *et al*., 1995). Building on successful campaigns such as tuna boycott, sustainable seafood initiatives have grown to include a broad spectrum of seafood products and now include consideration of the status of wild populations, exploitation measures, and the adverse effects of fisheries on ecosystems.

It is vital to approach sustainable seafood purchasing from both a local and global perspective. Internationally, fish trade comprises approximately 40% of the world's fish production (Dommen, 1999; FAO, 2004). Problems arise when products are ambiguously labeled, lack sourcing, and species information (Jacquet and Pauly, 2006). The Marine Stewardship Council (MSC) (www.msc.org) established a movement promoting seafood product traceability to allow assessment of sustainability levels. The MSC assesses the sustainability of fisheries based upon the FAO Code of Conduct (MSC, 2006a). Fisheries recognized as sustainable by a MSC certified label provide informed consumers with the opportunity to purchase sustainable products (MSC, 2006b).

In North America, many organizations have focused sustainable seafood guidelines at regional and national levels. The widely used programs are the *Seafood Watch* program (www.seafoodwatch.org) developed by the Monterey Bay Aquarium and the *From Sea to Table* program developed by the Blue Oceans Institute (www.blueocean.org) (MBA, 2006a; BOI, 2006). In September 2006, the *SeaChoice* campaign (www.seachoice.org) was launched in Canada by Sustainable Seafood Canada. Sustainable Seafood Canada's *SeaChoice* originated as a collaborative effort among the Canadian Parks and Wilderness Society, the David Suzuki Foundation (www.davidsuzuki.org), the Ecology Action Centre (www.ecologyaction.ca), the Living Oceans Society (www.livingoceans.org) and the Sierra Club of Canada (www.sierraclub.ca) (Sustainable Seafood Canada, 2006). It was Canada's first national program, and complemented other campaign initiatives which focus on a provincial level of assessment, including the *Citizen's Guide to Seafood*, developed by the BC Chapter of the Sierra Club of Canada (Sierra Club of Canada-BC Chapter, 2006), the *State of the Catch* initiative produced by the David Suzuki Foundation (Tank, 2006), and the Vancouver Aquarium's *OceanWise* program (www.vanaqua.org) (Vancouver Aquarium, 2005).

The intent of sustainable seafood guidelines is to aid consumers in making sound decisions that help preserve marine ecosystems (MBA, 2006b; SeaChoice, 2006b). Unfortunately, in the present state there are many limitations with seafood purchasing guidelines. Currently, there are too many guidelines with little continuity among methods of assessment. Different organizations use separate models to determine the sustainability of seafood products. As well, not all seafood products can be assessed by the guidelines because of significant data deficiencies such as species or origin. Conflicting assessments and rankings can confuse consumers, which ultimately threatens the effectiveness of the guideline approach. Until there is a uniform system of sustainable assessment accepted by all groups involved, the value of campaigns will remain limited. In the future, it will become a necessity to implement a universal method of assessment and ranking to reduce ambiguity and confusion, ultimately allowing consumers to make informed seafood choices with ease.

Sustainability at the University of British Columbia (UBC)

With over 45,000 student, faculty and staff, coupled with a national and an international academic reputation, sustainability initiatives at the University of British Columbia (UBC) (www.ubc.ca) have the potential to be revolutionary (UBC, 2005). UBC emphasizes its commitment to sustainability in the official university document *TREK 2010: A Global Journey*. This document outlines the goals and visions for the University. The UBC Vision statement declares that UBC will "…promote the values of a civil and sustainable society…" and that UBC students will "…strive to secure a sustainable and equitable future for all." (UBC TREK, 2005). In 1997, UBC became the first university in Canada to develop a sustainability policy (UBC Board of Governors, 2005) and opened the very first Canadian Campus Sustainability Office (UBC, 2005). UBC's next step was to investigate projects exploring mechanisms to reach sustainability goals. The SEEDS (Social, Ecological, Economic Development Studies) program (www.sustain.ubc.ca) provides students with the opportunity to investigate sustainability issues and possible solutions at UBC (UBC TREK, 2005).

UBC Sustainable Seafood Project

The *UBC Sustainable Seafood Project: Moving Towards Sustainable Seafood at UBC* was established in 2005 as a collaborative partnership among the Sustainability Office SEEDS program, the UBC Fisheries Centre's Project Seahorse, the Faculty of Land and Food Systems, UBC Food Services, and AMS Food and Beverage (Magera, 2006). Recently, Green College joined as a participatory collaborator in the project. The UBC Sustainable Seafood Project meets part of the SEEDS Ecological Sustainability Goals that strive to "Protect Biodiversity" (UBC Sustainability Office, 2006). The objective is to "ensure that the university community understands the value and importance of a healthy ecosystem, and follows the principles and practices articulated in the University's policies on sustainable development, environmental protection, and the management of hazardous materials" (UBC Sustainability Office, 2006).

The preliminary assessment identified four major seafood products as unsustainable choices and promptly removed from the menu at UBC (Magera, 2006). Phase II of the project continues to address the complex task of identifying unsustainable seafood purchasing at the taxon level, as well as incorporating social and economic concerns into the assessment. The current study will provide a more in-depth review of the sustainability of bivalves purchased by UBC Food Service and AMS Food and Beverage.

Bivalves are shellfish including over 30,000 species separated into four major groups: scallops, clams, mussels, and oysters (Brusca and Brusca, 2003). UBC food service providers currently used bivalve products sourced from regional, national, and international locations. Wild capture and aquaculture are methods used to harvest bivalves. Increased concerns surrounding the impact of the wild capture methods have lead to the expansion of aquaculture activities (Naylor *et al.*, 2000). Traceability of bivalve products purchased by UBC identifies numerous issues of ecological, social, and economic sustainability. Details of wild population status, native habitat, and harvest methods can be used to assess ecological sustainability of products. However, the assessment of social and economic sustainability is challenging and must include all stakeholders involved in bivalve fisheries. This assessment will make recommendations to UBC food service providers regarding the sustainability of the bivalve products currently purchased.

BIVALVE PURCHASING AND CONSUMPTION PATTERNS AT UBC

UBC Food Services

UBC Food Services purchased 70.96 tonnes of seafood from 2003 to 2005. Bivalves accounted for 9% of the total seafood purchased. Scallop products accounted for 68% (4.18 tonnes) (Table 1) of the total bivalves purchased at UBC. Seven different scallop-labeled products were purchased (Table 1) and four species were identified: Bay scallops (*Argopecten irradians*), Calico scallops (*Argopecten gibbus*), Pink scallops *(Chlamys rubida)* and Weathervane scallop (*Patinopecten caurinus*). Bay scallops and Sea scallops accounted for more than half of the total bivalves purchased (Table 2). One scallop product harvested in Canada remains unidentified. Albion Fisheries Ltd., UBC Food Service's primary supplier of bivalves, has been contacted requesting the sourcing details

- origin, species name, and method of harvest - of the unidentified product and the company's response is still pending upon the submission of this report.

Clams comprise a smaller proportion (1.81 tonnes) (Table 1) of the total bivalves purchased by UBC Food Services. Six different clam-labeled products were purchased (Table 1) and two species could be identified: Manila clams (*Venerupis philippinarum*) and Savory clams (*Nuttallia obscurata)*. Manila clams were the third-ranked product purchased in terms of quantity (Table 2). However, three clam products remained unidentified and further sourcing information is required from Albion Fisheries Ltd. and Sysco, which have been requested from the suppliers.

Table 1: UBC Food Services product supply totals for scallops, clams, mussels and oysters from 2003 to 2005. All products were supplied by Albion Fisheries Ltd. except baby clams and smoked oysters, for which the suppliers are unknown.

Code	Product	Yearly Usage (Kg)			3 Year Total
		2003	*2004*	*2005*	
15105210	Calico	100	0	0	100
15107110	No shell	80	0	5	85
25103126	120-150	1680	0	144	1824
25101203	Under 10 IQF	0	459	27	486
25101215	10-20 IQF	693	120	143	956
25101245	20-30	490	0	5	495
25101260	30-40	79	30	126	235
Scallop Total		**3122**	**609**	**450**	**4181**
25200250	Clam meat-chopped	120	0	0	120
25200265	-IQF small	0	115	0	115
25200267	-IQF medium	120	0	115	235
15200108	Clams-savory	173	50	0	223
15201110	Clams-manila no shell	0	537	37	574
	Baby clams	178.5	214.2	153	545.7
Clams Total		**591.5**	**916.2**	**305**	**1812.7**
15405110	Mussels-no shell	11	0	13	24

25203110	Mussels-half shell	0	0	56	56
Mussel Total		**11**	**0**	**69**	**80**
15309112	Oyster-no shell	0	0	0	0
25300120	Oyster-raw, half shell	0	0	7	7
15300245	Oyster-raw, medium	0	0	0	0
	Smoked oysters	8.16	12.24	27.7	48.1
Oyster Total		**8.16**	**12.24**	**34.7**	**55.1**
Bivalve Total					**6128.8**

Mussel and oyster products purchased by UBC Food Services combined account for 2% of the total bivalves purchased. Four products purchased were labeled (two labeled as mussels and two labeled as oysters) (Table 2) of which Eastern Blue mussel (*Mystiques edulis)* and Pacific oyster *(Crassostrea gigas*) species were identified. The species and origin of the canned smoked oyster product, purchased from Sysco, could not be identified and the sourcing information has been requested. All other mussel and oyster products were purchased from Albion Fisheries Ltd.

Table 2: UBC Food Services purchased quantities for individual species from 2003-2005. Note: ** indicates unidentified products*

Species (*Scientific name*) → *Origin*	**Quantity (Kg)**
Bay scallop *(Argopecten irradians)***→ China**	1800
Sea scallop (*Placopecten magellanicus)***→ CDN Atlantic**	1400
Manila clams (*Tapes pilippinarum*)	700
*** Baby Clam meat** (Unidentified species)	500
Weathervane Scallop (*Patinopecten caurinus)***→ Alaska Pacific**	500
*** Unidentified clam products**	400
*** Unidentified scallop products → CDN**	300
Savory clam (*Nuttallia obscurata*) **→ BC & Washington Pacific**	200
Calico scallop (*Argopecten gibbus*)**→ US Atlantic**	100
Pink Scallop (*Chlamys rubida)***→ *CDN Pacific***	90
Eastern Blue mussel (*Mystiques edulis*)**→ CDN Atlantic**	80
*** Smoked oyster** (Unidentified species)	50

Pacific oyster *(Crassostrea gigas)* → **BC & Washington Pacific**	7
Total	**6130**

AMS Food and Beverage

AMS Food and Beverage purchased only 8.58 tonnes of seafood (Magera, 2006. Bivalves accounted for a small portion of their total seafood purchases, 0.013 tonnes (13 kg) (Table 4). The only bivalve products purchased were scallops and mussels. Scallops were the 9th most purchased seafood product by AMS Food and Beverage contributing 77%, to the total bivalves purchased in a 12-month period. There were only two scallop products purchased and two species were identified, Bay scallops, purchased from Nishimoto Trading Co. Ltd. and Sea scallops from Sysco suppliers (Table 3). Recently, records show that AMS Food and Beverages has increased their purchasing of bivalves in 2006 (Table 5). However, only scallops were purchased and a new species was included, the Icelandic scallop (*Chlamys islandica*), which was ordered from a new supplier, Neptune Seafood Ltd.

Only one mussel product (0.003 tonnes) was purchased by AMS Food and Beverage accounting for 23% of the total bivalve purchases. This product was ordered from the Blundell Seafood Ltd. and was identified as the Eastern Blue mussel, cultured in Prince Edward Island.

Table 3: AMS Food and Beverage product supply records for July 2004 - January (end) 2006.

Code	Product	Supplier	19 Months (Kg)	12 Months Estimate (Kg)

90128	Bay scallops	Nishimoto	9.09	
71723 (Vender No. OceanFood Sales: 1642)	Scallop NUG BAC WRPD 21-25CT	Sysco	6.8	
Scallop Total			**15.89**	**10**
140520	Mussel, live, PEI	Blundell	4.5	
Mussel Total			**4.5**	**3**
Bivalve Total			**20.39**	**13**

Table 4: AMS Food and Beverage purchased quantities of individual species, 12-month estimate based on data collected from July 2004 – January 2006

Species (Scientific name) → *Origin*	Quantity (Kg)
Bay scallop (*Argopecten irradians*) → ***China***	6
Sea scallop *(Placopecten magellanicus)* → ***CDN Atlantic***	4
Blue mussel *(Mytilus edulis)* → ***CDN Atlantic (PEI)***	3
Total	**13**

Table 5: AMS Food and Beverage purchased quantities of individual species from June 2006 – November 2006. *See Appendix 1 for record details.*

Species (Scientific name) → *Origin*	Quantity (Kg)
Bay scallop *(Argopecten irradians)* → ***China***	170
Sea scallop *(Placopecten magellanicus)* → ***CDN Atlantic***	30
Icelandic scallop (*Chlamys islandica*) → ***Iceland / CDN Atlantic***	31
Total	**231**

BIVALVE FISHERIES AND AQUACULTURE

Bivalve Ecology

Taxonomy and Distribution

There are over 300 species of scallops identified worldwide and only a small number are large enough for commercial harvest and sale (Brusca and Brusca, 2003). Currently UBC food service providers have recorded purchases of six species (For maps of distributions see Appendix 4):

1) **Bay scallops** (*Argopecten irradians*), are native to the South Atlantic Ocean from New England to the southern United States (ED, 2005b; MBA, 2006c), and were introduced to Northeast China for aquaculture (Beaumont, 2000).
2) **Atlantic Sea scallops** (*Placopecten magellanicus*) are distributed from the Northwest Atlantic, the northern part of the Gulf of St. Lawrence to the coastal waters of North Carolina in the United States (DFO, 2006b).
3) **Weathervane scallop** (*Patinopecten caurinus*) are native to the Northeast Pacific Ocean from Alaska to Oregon (ED, 2005c).
4) **Iceland scallops** (*Chlamys islandica*) occur off the northwest coast of Iceland (IMF, 2005), and throughout parts of the mid Atlantic Ocean (Naidu et al, 1998).
5) **Calico scallops** (*Argopecten gibbus*) mainly inhabit the South Atlantic Ocean from the Gulf of Mexico along the east coast of Florida to South America (ED, 2005a).
6) **Pink scallops** *(Chlamys rubida)* are found on the Northeast Pacific Ocean from Alaska to Oregon (DFO, 2006a).

Some of the scallop products in UBC purchasing records could not be identified to species and may be any of the six species mentioned above.

Two species of clams were identified from the UBC food service providers purchasing records: Manila clams and Savory clams. The Manila clam is native to the Western Pacific Ocean in areas of Japan, Korea, China, and the Philippines but invaded the Eastern Pacific Ocean from central British Columbia (BC) to California in the early

1900s (DFO, 2001a). Savory clams, also referred to as Varnish clams, occur naturally from the Japanese islands to Korea extending to China. Recently, this species invaded the western Pacific coasts of North America ranging from northern Puget Sound to Oregon (DFO, 2001b). The remaining unidentified clam products could be one of the five major species of clams consumed globally: Manila, Savory, Geoduck, Littleneck, or Butter clams (BCSGA, 2005a). Geoduck clams (*Panopea abrupta*) are distributed in the Northeastern Pacific Ocean from Alaska to the California, inhabiting intertidal zones at depths of 110 m (DFO, 2000). Littleneck clams (*Protothaca staminea*) are a small, hard-shelled clam distributed from the Alaskan Aleutian Islands to Baja California, in mid to lower intertidal zones (DFO, 1999). Butter clams (*Saxidomus giganteus*), distributed throughout the coasts of the mid Pacific Northwest, and are common in protected beaches in bays and estuaries (Rodger, 2006).

The Eastern Blue mussel (*Mytilus edulis*) is the only identified species of mussels purchased by UBC Food service providers and this species occurs naturally on both the Pacific and Atlantic coasts of North America. The unidentified product, purchased by UBC Food Services from Albion Fisheries Ltd., may be the Eastern Blue mussel or the Mediterranean mussel (*Mytilus galloprovincialis*) which is a product listed in the Albion Fisheries Ltd. Catalogue (Albion Fisheries Ltd., 2006). The Mediterranean mussel is native to the Mediterranean coast and was introduced to the Pacific and Atlantic coasts of North America, China, Korea, Japan, southwestern Australia, Tasmania, parts of New Zealand, and southwestern South Africa (MBA, 2006d; Gillespie, 1999a; DFO, 1997).

The Pacific oyster *(Crassostrea gigas)* is the only species of identified oyster purchased by UBC food service providers. The Pacific oyster, which is native to Japan and was brought to western North America for cultivation to reestablish the oyster fishery after the native Olympia oyster (*Ostrea conchaphila*) collapsed due to over harvesting (Gillespie, 1999b; BOI 2004; DFO, 2006c). The Olympia oyster is the only native species on the west coast of Canada, large enough to be harvested (DFO, 2006c; BCSGA, 2005b; Gillespie, 1999b). The unidentified product may be the Pacific oyster species, the Olympia oysters, or the Atlantic oyster (*Crassostrea virginica*).

Life Histories

Bivalve reproduction occurs through synchronized annual broadcast spawning (Brusca and Brusca, 2003). Most bivalves have separate sexes, with hermaphroditic individuals occurring rarely. In reproduction each individual releases millions of eggs and sperm into the water column. Fertilization of the eggs occurs externally, and planktonic larvae develop (Brusca and Brusca, 2003). These larvae are free-swimming and feed on plankton for up to 4 weeks (Caddy, 1989). Scallops and mussels prefer settlement on hard surfaces. Metamorphosis causes a physiological change in the organisms, allowing them to secrete byssal threads, which cement them to the substrate as they develop their shells. Oysters settle in a similar way, only secreting a liquid cementing substance instead of byssal threads (Caddy, 1989). Clams do not attach themselves to a substrate, but continue to develop on the ocean floor after settling (Caddy, 1989; Rodger, 2006; Brusca and Brusca, 2003).

Bivalves are efficient filter feeders, extracting plankton out of the water; on average, these organisms can pump around 4 liters of water per hour through their natural filtering systems (Brusca and Brusca, 2003). Filter feeding allows bivalves to remain stationary as they forage, relying on the currents to bring food to them thus remaining in the same general geographic location throughout their lives.

Growth rates of bivalves are heavily dependent on environmental conditions such as temperature and currents, food availability and foraging efficiency. Deep-water aquaculture systems produce growth rates twice as fast as intertidal aquaculture systems and are an important consideration when designing integrated aquaculture systems. Scallops, clams, and oysters take from 1-4 years to reach a harvestable size, depending on the species and region (DFO, 2007; BCSGA 2005a). In the Atlantic Ocean, cultured Blue mussels grow to 50 mm, commercial size, in about 18-24 months (PEI-DAFA, 2003).

High fecundity, the production of a large amount of sperm and eggs to ensure successful fertilization, is a life history strategy of bivalves that has allowed fisheries to disregard the effects of over-harvesting in past management plans. Today, it is recognized that bivalve populations harvested to low densities may undergo depensatory responses, with fertility further reduced at low density because of limited spawning ranges (Peterson, 2002). Population dynamics are difficult to quantify and complicate management strategies when estimating sustainable fishing mortalities. Furthermore, the natural mortality rates of bivalves are poorly understood and differ with locality, age structure, and physical conditions, and the structure of the benthic community (Peterson, 2002).

Conservation and Management Status of Bivalves

Bivalves are harvested commercially by wild capture and aquaculture systems. Hand picking, raking, dredging, and small trawl-netting are wild capture methods employed to harvest bivalves (Naylor, 2000; Deo, 2002; Gilkinson *et al.*, 2006).

1) Harvest by hand involves digging for clams, inter-tidal collection of mussels and oysters, as well as dive collection of deep-water scallops, clams, and oysters. This method of harvest does minimal damage to the surrounding ecosystem and is target-specific, meaning little or no concern for by-catch. The potential for over-harvesting a population is relatively low, compared to other harvesting methods because landings are limited by human effort, and involve minimal mechanical devices.

2) Deep-water raking and dredging bivalves are harvesting methods designed to increase bivalve landings per unit effort, using mechanical devices. However, these devises have little consideration for the impacts inflicted on the target populations, the sea floor, and the benthic community (Hofmann and Powell, 1998; Gilkinson *et al.*, 2006; Gordon *et al.*, 2006; Rice, 2006). Rakes and dredges are made of heavy metal equipment, connected to powerboats, and dragged along the ocean bottom. This method of fishing is highly non-specific. There is concern in these fisheries for the risk of bycatch of organisms that are already

exploited in large-scale fisheries, such as large groundfish, crabs, and lobster. Unwanted mortality of the target bivalve population not included in the landing is also a concern of these harvesting methods because the heavy equipment damages individuals and leaves them behind on the ocean's floor (DFO, 2006d; Gilkinson, *et al*., 2006; Rice, 2006). Initiatives have been attempted to reduce by-catch pressure and minimize the benthic damage of wild harvest equipment. Prototype light-weight and flattened scallop dredges are being used on the east coast of the United States in effort to minimize the by-catch of large groundfish and sea turtles (NOAA, 2005).

3) Small trawl systems have been developed in British Columbia to capture swimming scallops by disturbing the population with dangling chains, causing individuals to swim up into trawl nets (DFO, 2006a). Initiatives have been attempted to reduce by-catch pressure and minimize the benthic damage of wild harvest equipment. Prototype light-weight and flattened scallop dredges are being used on the east coast of the United States in effort to minimize the by-catch of large groundfish and sea turtles (NOAA, 2005). Recently, a small trawl system was developed in BC to capture swimming scallops by disturbing the population with dangling chains, causing individuals to swim up into trawl nets (DFO, 2006a). Although concern regarding ecosystem damage and by-catch are a reality, further recognition, documentation, and significant research is needed for large-scale changes to be implemented (DFO, 2006a).

As natural bivalve populations are threatened with depletion (FAO, 2004; Delgado *et al.*, 2003) and the impact of wild capture methods are recognized as causes for concern, aquaculture efforts are being viewed as an opportunity to ease the rising social, economic and ecological pressures (Caddy and Defeo, 2003; Delgado *et al*., 2003). Aquaculture of bivalves is a relatively sustainable practice because, unlike finfish aquaculture, it does not require the addition of a food source and maintenance is much simpler (Naylor, 2000). However, the increasing intensity of bivalve aquaculture presents concern for potential ecological damage. The desire for larger and faster-growing exotic species to be cultured in local waters, presents the potential introduction of new non-indigenous species (BCSGA, 2006c). As well, intense aquaculture systems have unknown effects on the nutrient dynamics in a localized habitats. There may be depletion of microorganisms in the water column and increased waste accumulation on the sea floor, as well as adverse alteration to marine bird nesting grounds, feeding and migrating habitats (Caddy and Defeo, 2003). Future proposed ventures of exploiting aquaculture should be approached with caution because of the many potential issues that still linger (McKindsey *et al*., 2006).

SUSTAINABILITY OF UBC'S USE

Even though UBC currently purchases a small portion of bivalve products, there is potential for trends to change in the future. Therefore, by increasing awareness towards the sustainability of bivalve products purchased at UBC the university assumes responsibility for its contribution to the concerns facing the world's oceans. Below is an investigation of the sustainability of the various bivalve products purchased by UBC and recommendations to improving the current sustainability.

Scallops

Bay scallops and Sea scallops (Tables 1-3) were the most purchased bivalve products by UBC Food Services and AMS Food and Beverage. The Bay scallops UBC purchases are cultured and imported from China. The aquaculture of scallops is benign when compared to intense wild harvest. Therefore, the origin of Bay scallops is of particular sustainability concern. Bay scallops were introduced to the Eastern Pacific Ocean for aquaculture development, primarily in China. The sustainability of this introduction is questionable because of the unknown effects on local species of scallops. Native Bay scallops are available from the Eastern Atlantic coast of North America; however, these products tend to be more expensive because of higher production costs. There is also potential for wild stock depletion as scallop aquaculture is under developed on the Atlantic coast of Canada.

The Sea scallop fishery on the east coast of North America is a large and economically important operation (DFO, 2006b). Harvests of wild populations are high intensity due to deep-water dredging. As mentioned above, this is a highly unsustainable method of harvest because of the damaging effect the equipment has on the surrounding ecosystem and the future of target species. Damage to the ocean floor and benthic organisms, the large by-catch association with deep-water dredging, and high fishing mortality make Sea scallops an unsustainable choice.

The Weathervane scallops currently purchased by UBC are harvested by dredging methods. Even though this is a localized species native to the Northwest Pacific coast, there are sustainability issues associated with the ecological impacts of dredging methods. UBC Food Services purchased a much smaller quantity of Calico scallops and Pink scallops. Calico scallops are imported from the Atlantic coast of the United States. Fisheries closures of over harvested wild populations of Calico scallops have been reported and the long-term effects of the decreased population size are unknown (FWRI, 2006). Pink scallops are a native species to the Pacific coast of North America with a small-scale wild fishery in BC. The harvesting methods for this species include dive collection and small trawl systems, considered ecologically sustainable methods. The management of fishing mortality for local Pink scallops, does not allow for substantial decreases in population size, making them a relatively sustainable choice (Orensanz *et al.,* 2003).

Recommendations:

Currently, farmed Weathervane scallops and wild caught Pink scallops are the most sustainable alternatives. The sustainability concerns of the current Bay scallop products purchased by UBC are substantial; however, there is not currently a straightforward alternative. Purchasing of Sea scallops should be avoided because of ecological sustainability concerns mentioned above, however Sea scallops are the largest of all the scallops and a suitable substitution is often difficult to find. Icelandic scallops are not much smaller then the Sea scallop, yet the sustainability of these products have concerns to the harvest, which parallel of Sea scallops and should be avoided. Minimizing the quantity of Bay scallop, Sea scallop, and Icelandic scallop products will increase the sustainability of the scallops purchased by UBC. Calico scallop purchases are small quantities relative to other species and should be eliminated, given the concerns of unsustainable dredging harvest as well as decreasing populations. Switching wild harvested Weathervane scallop products to a locally farmed product would relieve the concerns associated with dredging harvests. Alternative products to replace the products recommended for removal or minimizing, must consist of local and native species, harvested from culture systems, small trawl systems or diving collection.

Clams

Manila clams (*Venerupis philippinarum*) and Savory clams (*Nuttallia obscurata*) were the only species of clams purchased by UBC and are both introduced species to BC. Studies suggest that these two species do not occupy the same ecological niche as native clams (DFO, 1999a; DFO, 1999b) and therefore are not an invasive threat; however, this may change in the future. Aquaculture systems for Manila and Savory clams in BC are the most sustainable choice for clam products.

<u>Recommendations:</u>

Since no evidence has indicated that Manila and Savory clams are affecting the native clam species, UBC may continue with its present purchasing practices of these clam products. Even if further investigation of the invasibility of the introduced species leads to evidence of competition between the introduced and native species, there is little that can be done to reverse the process, as both Manila and Savory clams are well established in B.C.'s local waters. If UBC food service providers or consumers desire a local and native product, the wild Geoduck clam fishery is well managed to protect stock sizes and recently, there has been local development of Geoduck aquaculture (BCSGA, 2006). The acceptance of Geoduck as a regularly purchased shellfish product is questionable however, as it is an expensive alternative that may be desired in catering outlets only.

Oysters

Currently, UBC only purchases locally farmed Pacific oyster products. The Pacific oyster is not native to BC and was introduced for aquaculture purposes because of the depletion of the native, Olympia oyster, which is now listed by the Species at Risk Act of Canada (SARA) as special concern (DFO, 2006c). It is claimed by some that the Pacific oyster, which is native to the western Pacific, cannot successfully reproduce in the eastern Pacific waters (Chew, 1990). There is still little evidence available, however to support this claim and so the potential invasive effects of the Pacific oyster on native species cannot be discounted.

Recommendations:

Until there is further, substantial evidence of the extent of the invasion of the Pacific oyster in local waters, it is recommended that UBC continue to purchase locally cultured products. Locally cultured Olympia oyster is also a sustainable option, but wild harvest of this species should be avoided because of their conservation concerns.

Mussels

The Eastern Blue mussels (*Mytilus edulis*) purchased by UBC are imported from Prince Edward Island (PEI) and produced by well-developed aquaculture systems (PEI-DAFA, 2003). There is a sustainability concern relating to the unnecessary use of fossil fuels, in airplane and trucking transport, to import mussel species across Canada.

Recommendations:

For a more sustainable alternative to the Eastern Blue mussels, locally farmed Western Blue mussel (*Mytilus trossulus*) is recommended. Currently, the culture of the Western Blue mussel is under further development and it is hoped that in the future, the west coast aquaculture system will become as well developed as it is currently on the East coast of Canada. Until this advancement of the west coast mussel aquaculture occurs, this alternative may be difficult to implement.

RECOMMENDATIONS FOR UBC BIVALVE PURCHASING

Assessing the sustainability of the bivalve products purchased by UBC is a very complex task. In order to simplify the assessments each species was ranked according to the relevant categories reflecting potential sustainability concerns. The criteria used to rank the various products consisted of whether the product was local or imported to BC, whether the product was made from wild or cultured organisms, and whether the species was native or introduced to BC. Table 4 shows the ranking of the species purchased by UBC, species that are available to UBC but not identified as a purchased product, and sustainable alternatives.

Table 4: Bivalve product sustainability rankings of products currently purchased by UBC (**bold font**) products potentially available through supplier and sustainable alternatives (√ is the most sustainable choice and X is an unsustainable choice).

Ranking	Product	Local	Imported	Wild	Cultured	Native	Introduced	Source
	Scallops							
1	Weathervane scallop (*Patinopecten caurinus*)	√			√	√		
2	Bay scallop (*Argopecten irradians*)		X		√	√		
3	**Pink scallop (*Chlamys rubida*)**	√		√		√		**Albion**
4	**Weathervane scallop (*Patinopecten caurinus*)**	√		X		√		**Albion**
5	**Bay scallop (*Argopecten irradians*)**		X		√		X	**Albion/Sysco/Blundell/Nishimoto**
6	Bay scallop (*Argopecten irradians*)		X	X		√		
7	**Calico scallop (*Argopecten gibbus*)**		X	X		√		**Albion**
8	**Sea scallop (*Placopecten magellanicus*)**		X	X		√		**Albion/Sysco**
9	**Icelandic scallop (*Chlamys islandica*)**		X	X		√		**Neptune**
	Clams							
1	**Manila Clams (*Venerupis philippinarum*)**	√		√	√		X	**Albion**
2	**Savory Clams (*Nuttallia obscurata*)**	√		√	√		X	**Albion**
3	Geoduck Clams (*Panopea abrupta*)	√		X	√	√		Albion
4	Littleneck Clams (*Protothaca staminea*)	√		X		√		Albion
	Oysters							
1	**Pacific Oyster (*Crassistrea gigas*)**	√			√		X	**Albion**
2	Olympia Oyster (*Ostea conchaphila*)	√			√	√		Albion
3	Edible Oyster (*Ostrea edulis*)	√			√		X	Albion
4	Eastern/Atlantic Oyster (*Crassostrea virginica*)		X	X		√		Albion
5	Olympia Oyster (*Ostea conchaphila*)	√		X		√		
	Mussels							
1	Western Blue Mussels (*Mytilus trossulus*)	√			√	√		
2	**Eastern Blue Mussels (*Mytilus edulis*)**		X		√	√		**Albion/Blundell**
3	Western Blue Mussels (Mytilus trossulus)	√		X		√		
4	Eastern Blue Mussels (*Mytilus edulis*)		X	√		√		
5	Mediterranean Mussels (*Mytilus galloprovincialis*)	√			√		X	Albion
6	Mediterranean Mussels (*Mytilus galloprovincialis*)		X	X	√	√		Albion
7	New Zealand Mussels (*Perna canaliculus*)		X		√		X	Sysco
8	New Zealand Mussels (*Perna canaliculus*)		X	X	√	√		Sysco

CONCLUSIONS AND FUTURE DIRECTIONS

Although the total amount of bivalves purchased by UBC is only a small portion of the total seafood purchased, there is potential for an increase in purchasing due to the increasing need for alternatives relieving the concerns for depleted global finfish supplies. Therefore, it is important that all bivalve purchasing be assessed to ensure that the most sustainable choices are being made. Should it be determined that some bivalve purchases are not sustainable as they could be, then the assessment process of UBC bivalve purchasing will succeed in increasing the sustainability of UBC practices, by finding products of concern and making sound recommendations for future changes to bivalve purchasing. Along with the past assessment of UBC seafood purchasing trends from Phase I of the UBC Sustainable Seafood Project and the bivalve assessment completed during Phase II of the project, there are, further investigations being performed to ensure a thorough analysis of the sustainability of seafood purchasing at UBC. The ultimate goal is to assess all of the seafood products purchased by UBC and make certain that all purchases are executed in the most sustainable manner possible.

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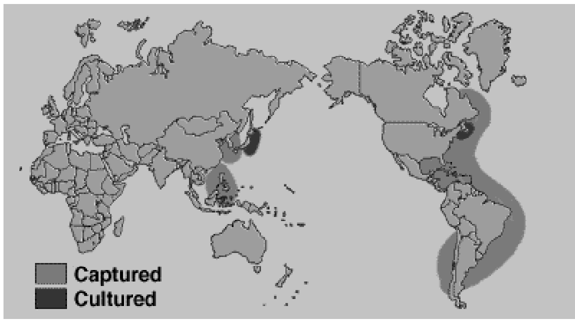
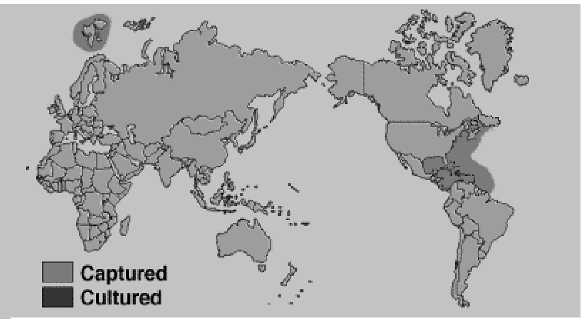
APPENDIX

Appendix 1: AMS Food and Beverage product supply records for June 2006 – November 10, 2006

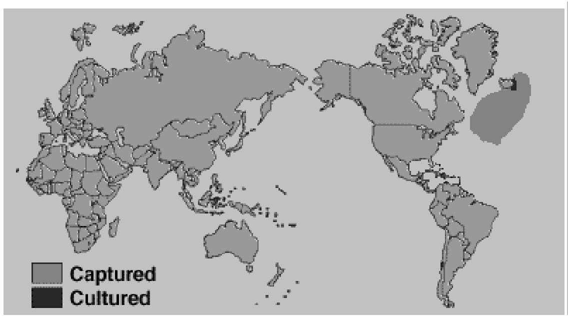
Code	Product	Quantity (Kg)
Neptune		
2650257	SCALLOP 80/120 ICELAND IQC	4.54
2650257	SCALLOP 80/120 ICELAND IQC	13.64
2650257	SCALLOP 80/120 ICELAND IQC	13.64
Sysco		
2734275	Scallop Bug Bac Wrpd 21 25 0185	4.54
71829	Scallop IQF Chinese 80-120 Ct	2.27
0165837	Scallop IQF Chinese 80-120 Ct	2.27
0165837	Scallop IQF Chinese 80-120 Ct	4.54
0165837	Scallop IQF Chinese 80-120 Ct	4.54
0165837	Scallop IQF Chinese 80-120 Ct	6.81
0165837	Scallop IQF Chinese 80-120 Ct	9.08
5375094	Scallop Nug Bac Wrap 21/25 01030	2.27
Blundell		
260055	Scallop, Chinese 100/200 IQF	13.6
260055	Scallop, Chinese 100/200 IQF	13.6
260840	Scallop, Chinese 100/200 IQF	13.6
260840	Scallop, Chinese 100/200 IQF	13.6
Nishimoto		
89122	Bay Scallop (150-200)	13.6
90751	Bay Scallop (80-120) 5 Lb	13.6
90128	Bay Scallop 120-150 Ep	13.6
90128	Bay Scallop 120-150 Ep	13.6
90128	Bay Scallop 120-150 Ep	13.6
90751	Bay Scallop (80-120) 5 Lb	13.6
90751	Bay Scallop (80-120) 5 Lb	13.6
90128	Bay Scallop 120-150 Ep	13.6
Total		**231.34**

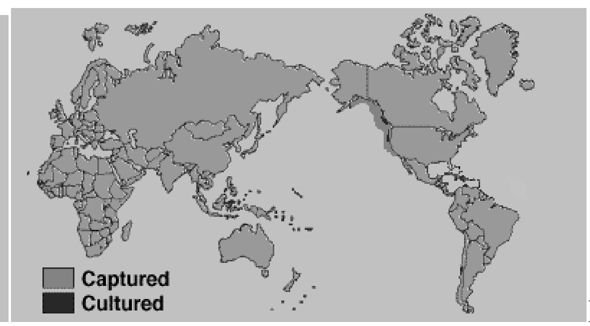
Appendix 2: Map of current species distributions. Note: *Includes native and introduced ranges.*





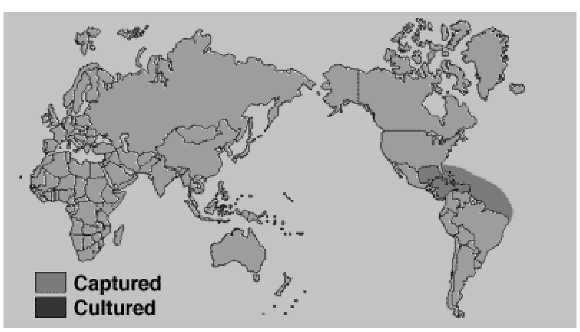
Bay scallop (*Argopecten irradians*)   Sea scallop *(Placopecten magellanicus)*





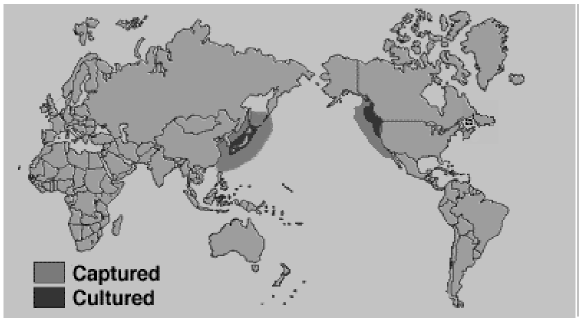
I

Icelandic scallops (*Chlamys islandica*)   Weathervane scallops (*Patinopecten caurinus)* and Pink scallops *(Chlamys rubida)*

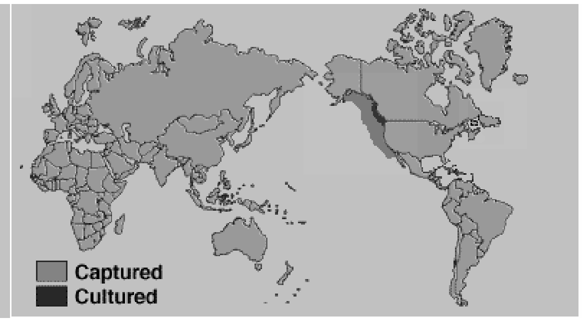


Calico scallop (*Argopecten gibbus*)

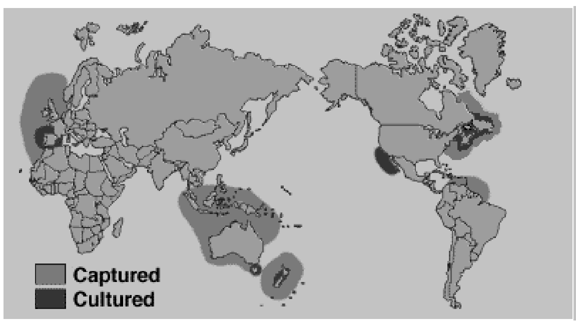
Appendix 2 continued: Map of current species distributions. Note: *Includes native and introduced ranges.*



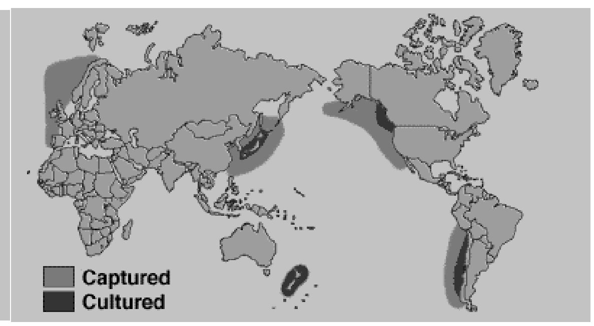
Manila clam (*Venerupis philippinarum*)
*Note: Savory clams (*Nuttallia obscurata*) have a similar distribution to Manila clams



Geoduck clams (*Panopea abrupta*)



Eastern Blue mussels (*Mytilus edulis*)



Pacific oyster (*Crassostrea gigas)*